Research and Development in Industry: 1994

Funds, 1994
Scientists and Engineers,
January 1995

Detailed Statistical Tables

Division of Science Resources Studies
Directorate for Social, Behavioral, and Economic Sciences
National Science Foundation

NSF 97-331

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Contributors

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INTRODUCTION

This report is the second of two publications produced from results of the 1994 Survey of Industrial Research and Development. The first, a Data Brief announcing the availability of survey results, contains analytical information and highlights the decreased share of R&D supported by the Federal Government during 1994. This report, the Detailed Statistical Tables report, contains the full set of statistics produced from the survey. Both publications provide statistics on research and development (R&D) funding for the years 1984–94 and on R&D personnel for the period from January 1985 to January 1995. (Both printed publications also are available on the World Wide Web at *http://www.nsf.gov/sbe/srs/stats.htm*.)

This report provides national estimates of the expenditures on R&D performed within the United States by industrial firms, whether U.S. or foreign owned. Among the statistics are estimates of total R&D, the portion of the total financed by the Federal Government, and the portion financed by the companies themselves (or by other non-Federal sources such as State and local governments or other industrial firms under contracts or subcontracts). Total R&D is also separated into its character-of-work components: basic research, applied research, and development. Other statistics include R&D financed by a domestic firm but performed outside the United States, R&D contracted to organizations outside of the firm, and the funds spent to perform energy-related R&D. This report also provides statistics on domestic net sales, number of employees, number of R&D-performing scientists and engineers, and cost per R&D scientist and engineer.

The Survey of Industrial Research and Development is an annual sample survey that intends to include or represent all for-profit, nonfarm R&D-performing companies, either publicly or privately held. The survey's primary focus is on U.S. industry as a performer of, rather than as a source of funds for, R&D. Thus, data on Federal support of R&D activities performed by industry are collected and resulting statistics appear in several tables, but statistics on industrial funding of R&D undertaken at universities and colleges and other nonprofit organizations are not collected and therefore are not included in the tables.[1] The result of collecting and publishing performer-reported statistics is that the federally funded R&D performance totals presented in this report differ from the Federal R&D funding totals reported by the Federal agencies that provide the funds and published in National Science Foundation's (NSF's) *Federal Funds for Research and Development* report series. One reason for these differences is that performers of R&D often expend Federal funds in a year other than the one in which the Federal Government provides authorization, obligations, or outlays. (For definitions of these terms, see section C under Comparisons to Other Statistical Series.) During the past several years, the differences have widened between the Federal R&D funding reported by performers and that reported by funding agencies. These trends are documented and analyzed in *National Patterns of R&D Resources: 1996* (NSF 96-333).

Industry statistics in this report are developed from data collected from individual companies or enterprises. Since the survey is enterprise based rather than establishment based, all data collected for the various subparts of each enterprise (plants, divisions, or subdivisions) are tabulated in the major standard industrial classification (SIC) of the company. The resulting industry estimates are reported using the SIC of the companies within each industry. National totals are estimated by summing the industry estimates.

All companies that spend more than $1 million annually on R&D in the United States or have 1,000 or more employees receive a survey questionnaire every year. These attributes are determined using information from previous surveys or other sources. Remaining firms are subjected to probability sampling and may or may not receive a questionnaire for a given survey year. Among the organizations purposely excluded from the survey are trade associations and not-for-profit consortia. Although their primary mission is to serve industry, these associations are established as nonprofit organizations.

[1] Data on R&D performed at universities and colleges are collected in the annual Survey of Scientific and Engineering Expenditures at Universities and Colleges. Resumption of a survey of other nonprofit organizations, discontinued in the mid-1970s, is underway. More information about these surveys is available from NSF's Research and Development Statistics Program in the Division of Science Resources Studies at the address given at the end of this introduction.

Respondents receive detailed definitions to help them determine which expenses to include or exclude from the R&D data they provide. Nevertheless, the statistics presented in this report are subject to response and concept errors caused by different respondent interpretations of the definitions of R&D activities and by variations in company accounting procedures.

The National Science Foundation's (NSF) Division of Science Resources Studies has sponsored and managed a survey of industrial R&D since 1953. The 1953–56 surveys were conducted by the Bureau of Labor Statistics (BLS), U.S. Department of Labor.[2] Since 1957, the Bureau of the Census, U.S. Department of Commerce, has conducted the survey.[3] Census staff conduct the survey under Title 13 of the United States Code, which prohibits publication or release of data or statistics that may reveal information about individual companies. Therefore, in some tables of this report the symbol "(D)" is used as a footnote reference to indicate that estimates are being withheld to avoid possible disclosure of information about operations of individual companies.

The content of the survey has been expanded and refined over the years in response to an increasing need by policymakers for more detailed information on the Nation's R&D effort. For example, questions on energy R&D were added in the early seventies, following the first oil-shortage crisis. On the other hand, the frequency of collection of certain data items has been reduced in recent years in an attempt to alleviate some of the respondent burden that has been placed on industry from all sources. For large firms known to perform R&D, a detailed questionnaire, Form RD-1L, is used to collect data for odd-numbered years and an abbreviated version, Form RD-1S, is used to collect data for even-numbered years. To further limit reporting burden on small R&D performers and on firms that are included in the sample for the first time, an even more abbreviated form, Form RD-1A, which collects only the most crucial data, is used each year. This report provides data collected from the Forms RD-1S and RD-1A.

Several changes have been made to the survey recently that are of special importance to users of this report. Prior to the 1992 survey, statistics were based on samples selected at irregular intervals (i.e., 1967, 1971, 1976, 1981, 1987). In intervening years a subset of the last sample (called a panel) was used. The most recent sample prior to the 1992 survey was selected and first used for survey year 1987. Original estimates for 1988 through 1991 were based on surveys of approximately 1,700 panel companies that reported R&D activity in the 1987 survey. Beginning with the 1992 survey, statistics are based on samples selected annually. Also, beginning with the 1992 survey, the sample size was increased from approximately 14,000 to nearly 23,400 firms. This increase was made for several reasons: (1) to account better for births of R&D-performing establishments in the survey universe, (2) to more fully and accurately survey R&D performed by nonmanufacturing firms, especially in the service sector, and (3) to gather more current information about potential R&D performers.

An analytical overview of the statistics developed from the survey data follows immediately. Tables containing the statistics are provided in section A. Detailed information about the history of the survey, survey methodology, comparability of the statistics, survey definitions, and other technical notes are provided in section B. Survey questionnaires, instructions, and other survey documents are reproduced in section C. Specific questions regarding the survey may be directed to Raymond Wolfe at (703) 306-1772, via e-mail at rwolfe@nsf.gov (Internet), or at the following mailing address:

Research and Development Statistics Program
Division of Science Resources Studies
National Science Foundation
4201 Wilson Boulevard, Suite 965
Arlington, VA 22230

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[2] See National Science Foundation, *Science and Engineering in American Industry: Final Report on a 1953-54 Survey* (NSF 56-16) and *Science and Engineering in American Industry: 1956* (NSF 59-50) (Washington, DC: Supt. of Documents, GPO, 1956 and 1960).

[3] Data obtained in the earlier BLS surveys are not directly comparable with Census figures because of methodological and other differences.

Analytical Overview

During 1994 the amount spent by companies in the U.S. on investigations for the advancement of science or to achieve commercial goals (basic and applied research) and activities aimed at translating results of these investigations into products or processes (development) amounted to $119.6 billion, 2 percent more than during 1993. However, after adjusting for inflation, the amount spent for industrial R&D during 1994 decreased 0.2 percent, having declined by 3.5 percent in constant dollars in 1993. This downward trend is only the second since 1953. The first occurred in the early 1970s when total R&D measured in constant dollars began falling and did not regain its 1969 level until 1978.

Eighty-one percent of total R&D performed during 1994 was financed by companies' own funds and 19 percent was financed by the Federal Government through contracts and grants, including the two percent of total R&D performed by Federally Funded Research and Development Centers (FFRDC) administered by industry. Company funding continued to increase, from $94.6 billion to $97.1 billion, as it has each year since 1953. Federal funding decreased from $22.8 billion to $22.5 billion, continuing a downward trend that began in 1988. After adjusting for inflation, the directions of these changes are the same: company-funded R&D rose 0.6 percent and Federally funded R&D fell 3.5 percent.

The share of R&D performed by firms in the nonmanufacturing industries decreased from 26 percent during 1993 to 24 percent, while manufacturers performed the remaining 76 percent. The remainder of this section will focus on the levels and trends of R&D performed by these two groups, with emphasis on the manufacturing industries. Beginning with the 1995 survey, more detailed statistics for the nonmanufacturing industries will be available. Instead of grouping all nonmanufacturing industries together, as has been done in this and in previous publications, about a dozen subgroups will be added to the 1995 tabulations.

Sources of R&D Funds

Federal Support

Among manufacturing industries, Federal funding accounted for $17.3 billion of total R&D with most of that amount, $8.8 billion, spent on research performed by companies that manufactured aircraft and missiles for the Department of Defense and the National Aeronautics and Space Administration. Although down 6 percent from 1993 levels, these firms received 39 percent of the Government's support of industrial R&D. Makers of professional and scientific instruments and of electrical equipment ranked second and third. Firms in those industries performed $3 billion and $2 billion of Federal R&D, respectively, and accounted for 23 percent of total Federal R&D. Manufacturers of machinery including computers, petroleum extractors and refiners, drug and medicine makers, and other manufacturers received 15 percent of Federal funding and performed $3 billion of the total Federal R&D.

Firms in nonmanufacturing industries as a group received $5 billion, a 23-percent share of total Federal support. Most of this support went to computer-related service firms and research, development, and testing firms.

Company Support

While the Federal government's share of support of R&D to most industry groups declined during 1994, the amount firms contributed to their own R&D efforts continued to grow. Manufacturing industries as a group spent $73 billion on R&D. Among the manufacturing industries, firms in transportation equipment, especially automobile makers, performed the largest amount of R&D during 1994, $18 billion, with chemical manufacturers including makers of drugs and medicines ranking a close second, $17 billion. Manufacturers of electrical equipment, including electronic and communication components, performed $14 billion of R&D. Together these three industry groups accounted for two-thirds of total company-funded R&D performed by manufacturers. Makers of professional and scientific instruments, machinery, petroleum

extractors and refiners, and other manufacturers performed the rest. Nonmanufacturing firms as a group spent $24 billion on company-funded R&D during 1994. Among nonmanufacturing performers, the largest were computer-related service firms, which spent $6 billion, and research, development, and testing firms, which spent $2 billion.

Character of Work

Manufacturing Industries

Chart 1 shows how total industrial R&D was distributed among its character of work components (basic research, applied research, and development) for manufacturing firms.

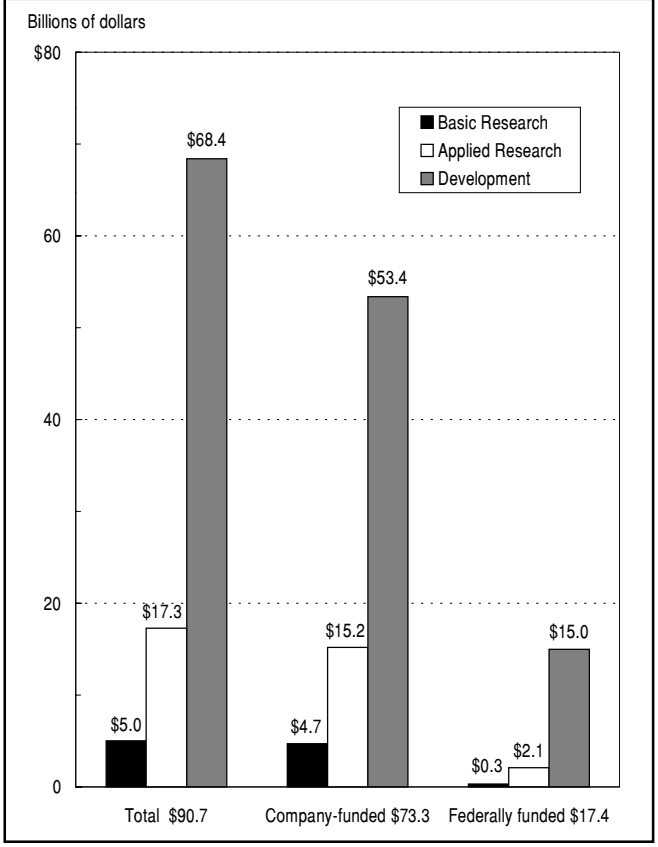
Research

Half of company-funded basic research performed by U.S. industry was performed by companies in the chemical and allied products classification ($3 billion). This group includes drug and medicine manufacturers for whom original experimentation is crucial for the discovery of new cures and pain killing compounds. About twelve percent ($0.1 billion) of Federally funded basic research performed in the U.S. was performed by manufacturers of transportation equipment, including aircraft and missiles. Among the large performers of company-funded applied research were manufacturers of drugs and medicines ($3 billion), professional and scientific instruments ($1 billion), and electronic components ($1 billion). About one-third ($0.8 billion) of Federally funded applied research was performed by manufacturers of transportation equipment.

Development

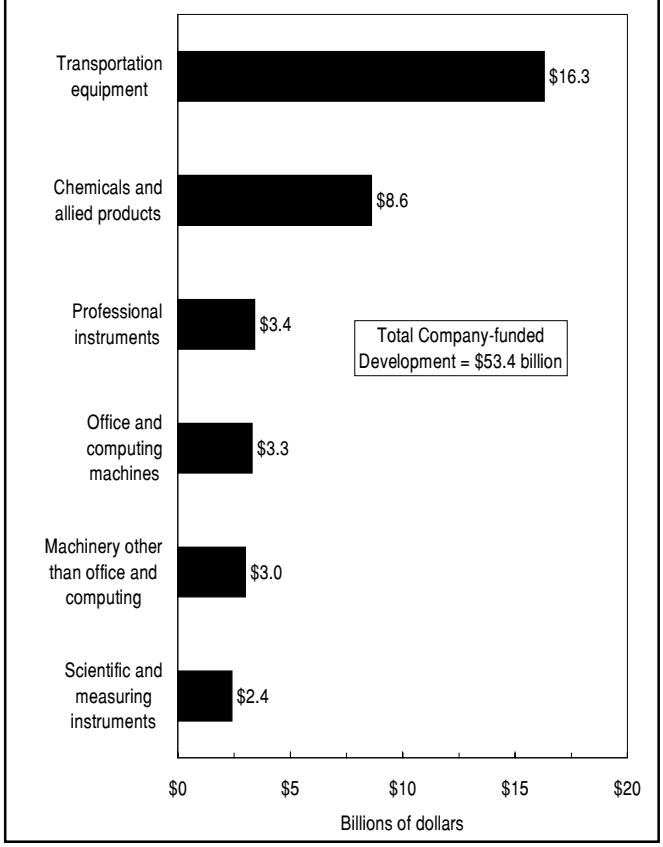
The point of most industrial R&D is to develop and market new goods and services. Chart 2 shows the major industry groups engaged in non-routine, company-funded technical activities aimed toward the development of commercial products or processes.

Chart 1. Total industrial R&D distribution by character of work in manufacturing industries, 1994



SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

Chart 2. Company-funded development performed by manufacturing industries, 1994



SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

NONMANUFACTURING INDUSTRIES

Chart 3 shows how total R&D was distributed among its character of work components (basic research, applied research, and development) for firms in the nonmanufacturing industries:

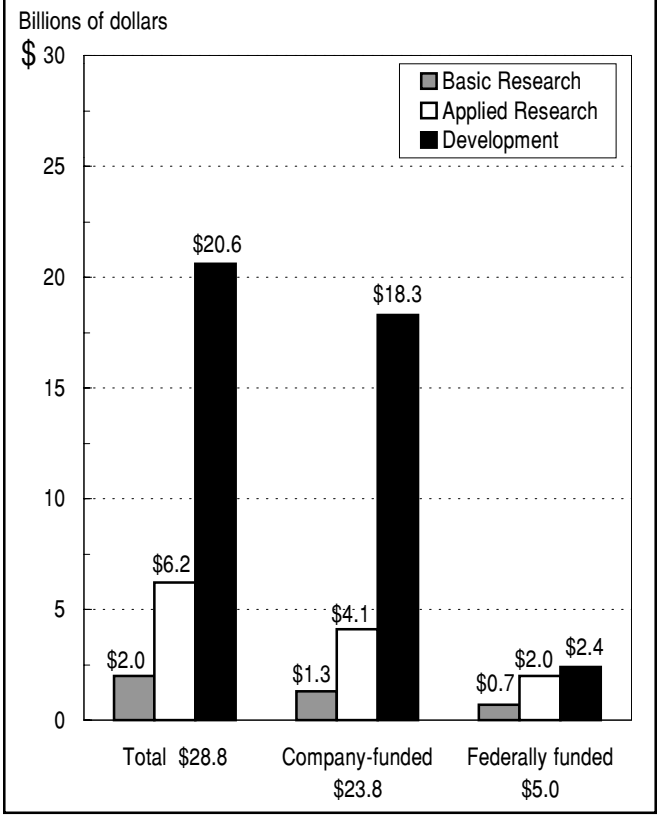
"OUTSIDE" R&D

In addition to collecting information on R&D performed by companies themselves, the survey collects information on R&D contracted out to other performers in the U.S. and on R&D performed outside of the U.S. by subsidiaries and foreign affiliates.

CONTRACTED R&D

About 12 percent of manufacturers and 10 percent of companies in nonmanufacturing industries contracted R&D to entities outside the company. On average these groups contracted out 2.7 percent and 4.0 percent of their total R&D performance, respectively. Entities that received the contracts included other industrial firms, commercial laboratories, consultants, educational institutions, and hospitals. Table 1 gives the amounts of contracted R&D financed by companies in major R&D-performing industry groups and indicates the percentage of company-funded R&D that was contracted out. Industries are arrayed beginning with those that contracted out the largest amount of R&D to those that contracted out the smallest amount of R&D.

Chart 3. Total industrial R&D distribution by character of work in nonmanufacturing industries, 1994



SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

FOREIGN R&D

On average, 8.0 percent of R&D performed by manufacturers and 4.9 percent of total R&D performed by firms in the nonmanufacturing industries was performed abroad. Table 2 gives industry levels of R&D (from highest to lowest) financed by U.S. companies but performed outside their domestic operations by subsidiaries in foreign countries, including Canada and Puerto Rico, and indicates the percentage of company-funded R&D that was performed abroad.

Table 1. Company-funded R&D contracted to outside organizations and the percentage of total company-funded R&D contracted out, by industry: 1994

	Company-funded contracted R&D	Percentage of total company-funded R&D contracted out
	[Dollars in billions]	[Percent]
Total	3.6	3.7
Nonmanufacturing industries	1.2	4.9
Drugs and medicines	1.1	11.0
Transportation equipment	0.6	3.3
Machinery	0.2	2.5
Electrical equipment	0.1	0.9
All other industries	0.5	1.7

SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

Table 2. Company-funded R&D performed abroad and the percentage of total foreign and domestic company-funded R&D performed abroad, by industry: 1994

	Company-funded foreign R&D	Percentage of total foreign and domestic company-funded R&D performed abroad
	[Dollars in billions]	[Percent]
Total	9.4	8.8
Drugs and Medicines	1.5	13.8
Nonmanufacturing industries	1.5	5.9
Industrial chemicals and chemicals other than drugs	0.9	11.7
Professional and scientific instruments	0.9	10.0
Electrical equipment	0.5	3.5
All other industries	4.0	10.3

SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

Included in the "all other industries" category are manufacturers of motor vehicles and other transportation equipment. Subsidiaries and affiliates of companies in this group financed $2.1 billion of foreign R&D during 1991 (statistics for 1992-94 have been suppressed and are not available because of disclosure[4]) and it is assumed that this industry group also ranked first among the manufacturing industries that financed foreign R&D during 1994.

Characteristics of R&D Performers

R&D and Firm Size

Performance of R&D by the smallest firms, those with less than five hundred employees, declined 4 percent during 1994 compared with 1993. For this group, Federally sponsored R&D declined 28 percent. For larger firms, those with between 500 and 5,000 employees, total R&D increased 10 percent and Federal R&D declined 2 percent. For the largest firms, those with 5,000 or more employees, company-funded R&D increased 2 percent and Federal R&D increased 1 percent. These year-to-year comparisons represent changes in the amounts and character of R&D performed as well as shifts in the size categories of the firms.

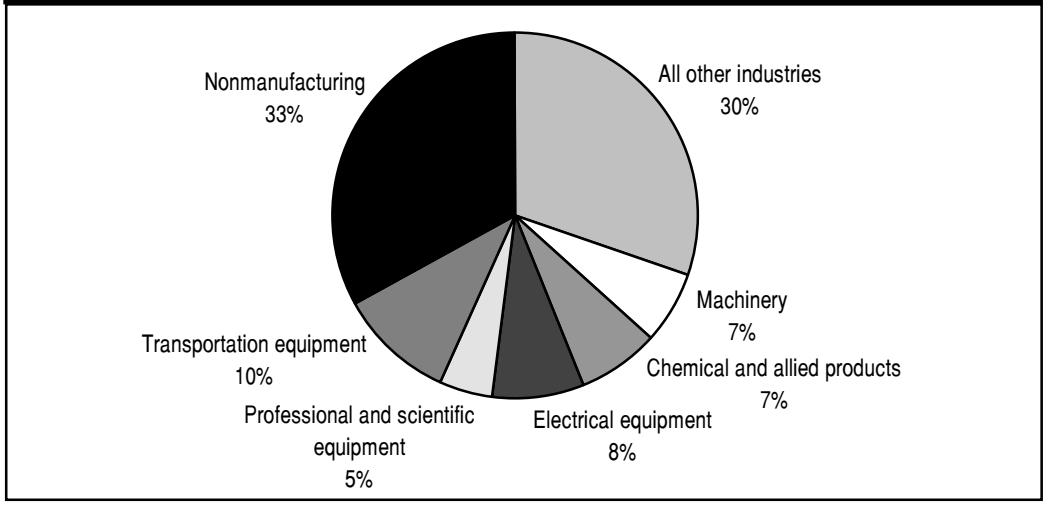
R&D as a Percent of Net Sales

Among manufacturing firms, R&D performers reported domestic operations sales of $2.5 trillion during 1994.[5] On average, these firms spent 4 percent of net sales on R&D during 1994. The smallest firms, those with fewer than 500 employees, spent 3 percent; the largest firms, those with 25,000 or more employees, spent 5 percent; and the firms in the categories between those two groups spent from 2.2 to 2.7 percent. The four manufacturers with the largest R&D programs collectively spent 6 percent of sales on R&D; the next four companies spent 17 percent, and the next twelve spent 9 percent. The three industry groups that spent the largest percentage of net sales on R&D were aircraft and missiles (14 percent), drugs and medicines (10 percent), and scientific instruments (11 percent). R&D-performing firms in the nonmanufacturing industries reported domestic operations sales of $1.1 trillion and spent an average of 3 percent of net sales on R&D.

Employment by R&D-Performing Firms

In addition to collecting information on the amount of R&D, the Survey of Industrial Research and Development also gathers information on the number of scientists and engineers who perform R&D. Of the 12 million people employed in the U.S. by manufacturers that performed R&D, the number of full-time equivalent (FTE) R&D scientists and engineers (those assigned full-time plus a prorated number of employees working part-time on R&D) was 571,100. R&D-performing firms in the nonmanufacturing industries employed 6 million people, 197,400 of whom were FTE R&D scientists and engineers. Compared with 1993, employment of FTE scientists and engineers rose 0.5 percent for both manufacturing and nonmanufacturing industries. Charts 4 and 5 show total

Chart 4. Total domestic employment for major R&D-performing industries, 1994



SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

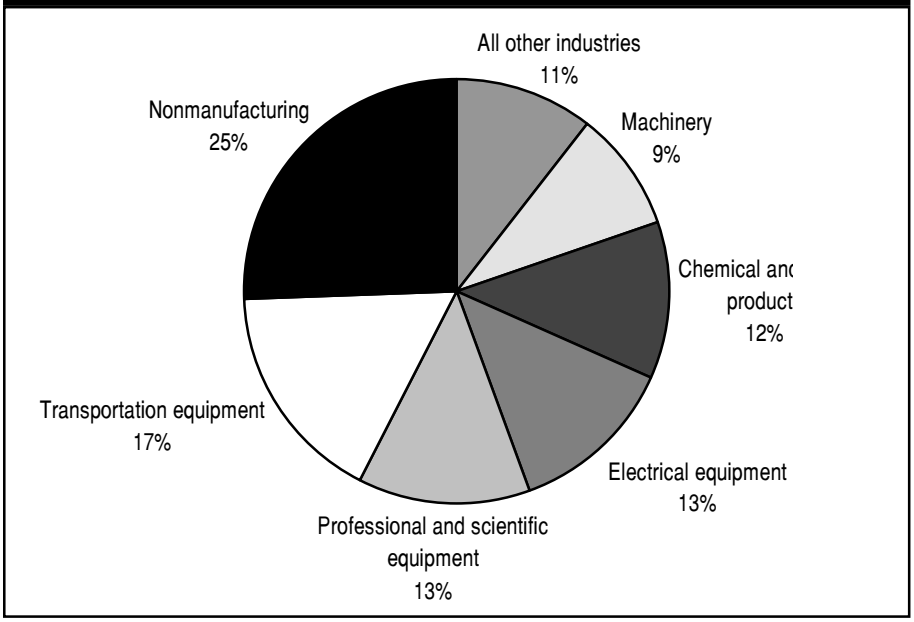
[4] See the table notes in section A for a detailed discussion of suppression of statistics.

[5] Sales are net value f.o.b. plant after discount and allowances, freight charges, and excise taxes.

domestic employment and the number of FTE R&D scientists and engineers for the industry groups that were major employers of R&D scientists and engineers during 1994.

The ratios of the number of R&D scientists and engineers to total employment are given in table 3 for each industrial group. Industries are arrayed beginning with those that employed the highest number of FTE R&D scientists and engineers to industries that employed the smallest number of R&D scientists and engineers.

Chart 5. Number of R&D scientists and engineers employed in major R&D-performing industries, 1994



SOURCE: National Science Foundation/SRS,
Survey of Industrial Research and Development: 1994

Table 3. Ratios of the number of R&D scientists and engineer to total employment

	Number of FTE R&D Scientists and Engineers	Total Domestic Employment	R To E
	[In thousands]		
Total	768.5	17,443.0	
Nonmanufacturing industries	197.4	5,765.0	
Transportation equipment	129.6	1,812.0	
Professional/scientific instruments	100.6	791.0	
Electrical equipment	96.5	1,433.0	
Chemical and allied products	93.1	1,225.0	
Machinery	70.4	1,143.0	
All other industries	80.9	5,274.0	

SOURCE: National Science Foundation/SRS,
Survey of Industrial Research and Development: 1994

NOTE TO USERS OF HISTORICAL STATISTICS

To obtain accurate historical statistics for 1984–92, use only the detailed statistical tables in this report and not those published earlier. Current-year (1994) and immediate prior-year (1993) statistics in trend tables were derived from the most recently completed survey cycle. Data for previous years were reviewed for consistency with current-year responses and may have been revised. Consequently, this report contains the latest revised statistics from the Survey of Industrial Research and Development for 1984–94.

Note particularly that, as a result of a new sample design, statistics for 1988–91 have been revised since originally published. These statistics now better reflect R&D performance among firms in the nonmanufacturing industries and small firms in all industries. See the technical notes in section B for more information.